CLAIMS

We claim:

1. A method for making a composite structure having a flexural modulus of at least 200,000 lb/in^2 wherein the composite structure includes at least one first-layer and at least one second-layer, said method comprising the steps of:

(a) providing a mold substrate;

(b) applying a first-layer of the composite structure to the mold substrate, said first-layer comprising the reaction product of a first-layer polyisocyanate component including an aliphatic polyisocyanate and a first-layer resin component including a polyamine and being substantially free of volatile organic compounds, wherein said first-layer is a show surface of the composite structure and has a Shore D hardness of at least 65; and

(c) applying a second-layer of the composite structure to said first-layer, said second-layer comprising the reaction product of a second-layer polyisocyanate component and a second-layer resin component including a polyol having a theoretical functionality of at least three and being substantially free of volatile organic compounds

(d) demolding the composite structure from the mold substrate.

2. A method as set forth in claim 1 wherein the step (b) of applying the first-layer is further defined as applying the first-layer to a thickness of from 1 to 500 mils.

3. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as applying the second-layer to a thickness of from 1 to 2000 mils.

4. A method as set forth in claim 1 wherein the step (b) of applying the first-layer is further defined as applying the first-layer such that the first-layer has a gel time ranging from 1 to 60 seconds.

5. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as applying the second-layer such that the second-layer has a gel time ranging from 1 to 15 minutes.

6. A method as set forth in claim 1 wherein the step (b) of applying the first-layer is further defined as applying the first-layer in a volume ratio from 1 : 3 to 3 : 1.

7. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as applying the second-layer in a volume ratio from 1 : 3 to 3 : 1.

8. A method as set forth in claim 1 further comprising the step of applying a mold-release agent to the mold substrate prior to the step (b) of applying the first-layer.

9. A method as set forth in claim 1 further comprising the step of tempering the mold substrate to a temperature ranging from 75°F to 125°F.

10. A method as set forth in claim 1 further comprising the step of incorporating propylene carbonate into the second-layer resin component.

11. A method as set forth in claim 10 wherein the step of incorporating propylene carbonate into the second-layer resin component is further defined as incorporating the propylene carbonate into the second-layer resin component in an amount from 1 to 15 parts by weight based on 100 parts by weight of the second-layer resin component.

12. A method as set forth in claim 1 further comprising the step of incorporating a cross-linking agent into the second-layer resin component.

13. A method as set forth in claim 12 wherein the step of incorporating the cross-linking agent into the second-layer resin component is further defined as incorporating the cross-linking agent into the second-layer resin component in an amount from 10 to 30 parts by weight based on 100 parts by weight of the second-layer resin component wherein the cross-linking agent comprises a diol.

14. A method as set forth in claim 1 further comprising the step of incorporating at least one additive into the second-layer resin component wherein the additive is selected from the group consisting of surfactants, flame retardants, fillers, dyes, water scavengers, anti-foam agents, catalysts, UV performance enhancers, pigments, hindered amine light stabilizers, and mixtures thereof.

15. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as repeating the application of the reaction product of the second-layer polyisocyanate component and the second-layer resin component such that the composite structure includes a plurality of second-layers.

16. A method as set forth in claim 15 further comprising the step of incorporating at least one structural reinforcement element between each of the second-layers.

17. A method as set forth in claim 16 wherein the step of incorporating at least one structural reinforcement element is further defined as incorporating at least one structural reinforcement element selected from the group consisting of wood, cardboard, foam, and combinations thereof.

18. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as incorporating chopped fibers into the second-layer reaction mixture to form the second-layer.

19. A method as set forth in claim 18 wherein the step of incorporating chopped fibers to form the second-layer is further defined as incorporating chopped fibers selected from the group consisting of chopped fiberglass, chopped carbon fibers, chopped wood fibers, chopped aramid fibers, chopped polymer fibers, and mixtures thereof.

20. A method as set forth in claim 18 wherein the step (c) of applying the second-layer is further defined as repeating the application of the reaction product of the second-layer

polyisocyanate component and the second-layer resin component such that the composite structure includes a plurality of second-layers.

21. A method as set forth in claim 20 further comprising the step of flattening the chopped fibers between application of the second-layers such that the chopped fibers are flattened between each of the second-layers of the composite structure.

22. A method as set forth in claim 21 wherein the step of flattening the chopped fibers between application of the second-layers is further defined as rolling the second-layers between application of each of the second-layers.

23. A method as set forth in claim 1 further comprising the step of applying a barrier layer comprising the reaction product of a barrier layer polyisocyanate component and a barrier layer resin component to the first-layer to form a barrier layer of the composite structure disposed between the first and second-layers.

24. A method as set forth in claim 23 wherein the step of applying the barrier layer is further defined as applying the barrier layer to a thickness of from 1 to 1000 mils.

25. A method as set forth in claim 23 wherein the step of applying the barrier layer is further defined as applying the barrier layer such that the barrier layer has a gel time ranging from 1 second to 2 minutes.

26. A method as set forth in claim 23 wherein the barrier-layer resin component includes a blend of a trimethylol propane – initiated polyether polyol having a hydroxyl number of 30 meq polyol / g KOH or more and an average functionality of from 2 to 3, and a vicinal toluenediamine – initiated polyether polyol having a hydroxyl number of 300 meq polyol / g KOH or more and an average functionality of from 3.5 to 4.5.

27. A method as set forth in claim 1 wherein the aliphatic polyisocyanate of the first-layer polyisocyanate component is selected from the group consisting of hexamethylene

diisocyanate, isophorone diisocyanate, hexamethylene diisocyanate initiated pre-polymer, and isophorone diisocyanate initiated pre-polymer, and mixtures thereof.

28. A method as set forth in claim 1 wherein the polyamine of the first-layer resin component is an aliphatic polyamine selected from the group consisting of polyoxyalkylene amines, polyoxyalkylene diamines, polyoxyalkylene triamines, and mixtures thereof.

29. A method as set forth in claim 1 wherein the second-layer polyisocyanate component comprises polymeric diphenylmethane diisocyanate.

30. A method as set forth in claim 1 wherein the polyol of the second-layer resin component is made from an initiator compound selected from the group consisting of glycerin, methyl glucoside, pentaerythritol, sorbitol, sucrose, toluenediamine, ethylenediamine, and mixtures thereof.

31. A method as set forth in claim 1 wherein the polyol of the second-layer resin component is made from an initiator compound comprising a mixture of sucrose and glycerin and having an average theoretical functionality of 7.

32. A method as set forth in claim 1 wherein the step (b) of applying the first-layer is further defined as spraying the first-layer.

33. A method as set forth in claim 1 wherein the step (c) of applying the second-layer is further defined as spraying the second-layer.

34. A method as set forth in claim 23 wherein the step of applying the barrier layer is further defined as spraying the barrier layer.

35. A method as set forth in claim 23 wherein said barrier layer is substantially free of volatile organic compounds.

36. A method for making a composite structure having a flexural modulus of at least 200,000 lb/in^2 wherein the composite structure includes at least one first-layer and at least one second-layer, said method comprising the steps of:

(a) providing a mold substrate;

(b) applying a first-layer of the composite structure to the mold substrate, said first-layer comprising the reaction product of a first-layer polyisocyanate component including an aliphatic polyisocyanate and a first-layer resin component including a polyamine and being substantially free of volatile organic compounds, wherein said first-layer is a show surface of the composite structure and has a Shore D hardness of at least 65; and

(c) applying a barrier layer to the first-layer to form a barrier layer of the composite structure disposed between the first and second-layers, said barrier layer comprising the reaction product of a barrier layer polyisocyanate component and a barrier layer resin component; and

(d) applying a second-layer of the composite structure to said barrier layer, said second-layer comprising the reaction product of a second-layer polyisocyanate component and a second-layer resin component including a polyol having a theoretical functionality of at least three and being substantially free of volatile organic compounds; and

(e) demolding the composite structure from the mold substrate.

37. A method for making a composite structure having a flexural modulus of at least 200,000 lb/in^2 wherein the composite structure includes at least one first-layer and at least one second-layer, said method comprising the steps of:

(a) providing a mold substrate;

(b) applying a polyurea component containing at least one UV performance enhancing additive to the mold substrate to form the first-layer of the composite structure that is substantially free of volatile organic compounds, wherein the first-layer is a show surface of the composite structure and has a Shore D hardness of at least 65; and

(c) applying a second-layer comprising the reaction product of a polyisocyanate component and a resin component including at least one polyol having a theoretical functionality of at least three to the first-layer to form the second-layer of the composite structure that is substantially free of volatile organic compounds; and

(d) demolding the composite structure from the mold substrate.